DOOSAN **Document Transmittal** Upper Trishuli-1 HEP (216MW)	Date 2022-07-10	DT No.: UT1-HEP-DHI-PC-D-0042	SHEET 1 OF 1
DOOSAN NEPAL BRANCH OFFICE Address & Contact No. : Four Square Building, Naxal, Kathmandu, Nepal (P.O Box : 1387) + 977 1 692 3014	Project No. H20002	DOCUMENT DISPATCHED BY Courier Service ☐ Messenger ☐ Post-Air Freight ☐ Document System or E-mail ■ By hand ■	
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SUBJECT	Review Note RN-0157_Monitoring Layout Drawing of Underground Powerhouse and Transformer Cavern		

S. N.	REVIEW NOTE NO.	REVIEW STATUS	DWG. / DOC. NO.	REV.	DWG. TITLE / DOC. DESCRIPTION	REMARK
1	RN-0157	AN	UT1-C-845-CVL-DG-70002	0B	Monitoring Layout Drawing of Underground Powerhouse and Transformer Cavern	
2						
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Received by :

Date :

Legend of Review Status
A : APPROVED
AN : APPROVED AS NOTED
RR : RETURN FOR RESUBMISSION
FI : FOR INFORMATION

DHI STAMP

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Doosan Heavy Industries & Construction Co., Ltd.

Discipline : Civil

UPPER TRISHULI-1 HEP (216MW)

Client	**Nepal Water and Energy Development Company Private Limited**
Owner's Engineer	**Tractebel Engineering GmbH / Jade Consult**

REVIEW NOTE

Contractor	**Doosan Enerbility**		
Title of the Document	Monitoring Layout Drawing of Underground Powerhouse and Transformer Cavern		
Document No.	UT1-C-845-CVL-DG-70002	Revision	0B
Date of Documents	14.06.2022	Received Date	22.06.2022
Transmittal Form No.	UT1-HEP-DHI-D-0282		
Previous Review Date/Status	05.06.2022/RR	Prev. Review Note No.	RN-0134
Review Note No.	**RN-0157**	**Present Review Date**	**08.07.2022**
		Present Review Status	**AN**

A: Approved AN: Approved as Noted RR: Returned for Resubmission FI: For Information, only

General Comments

Several of the given comments were incorporated in the revised documents. However, many issues remained unaddressed or were not specifically considered.

Beside specific technical issues that need to be further detailed, such as the protection of the extensometer heads, the remaining general issues/questions are:

When will be the instruments installed? How far away from the adjacent excavation face or bench?

Where will be the pore pressure cells be installed? In boreholes? Which boreholes?

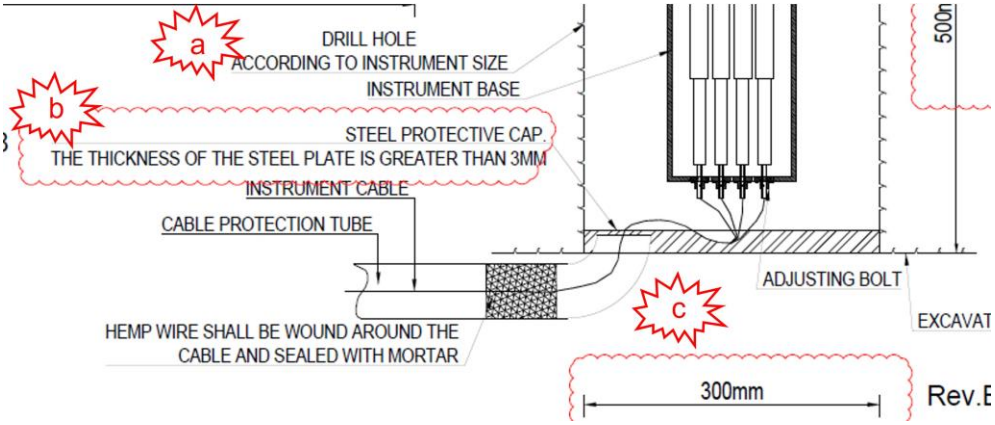
When and where will be the shotcrete stress meters be installed? (Evidently during shotcreting)

Only 3 load cells for the whole powerhouse roof with its 270 pre-stressed bolts? This is certainly insufficient.

The drawings are generally confusing. It may be helpful to provide drawings with all the instruments (e.g. sections) and drawings for individual types of instruments.

It is noted that the types of instruments are approved.

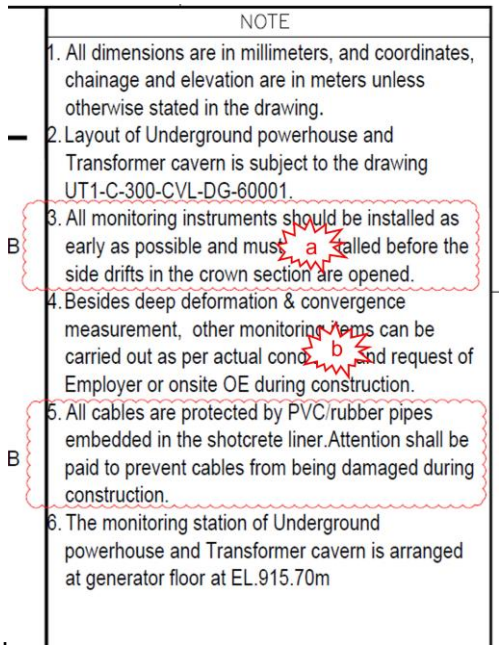
Drawing No.: UT1-C-845-CVL-DG-70002 (sh. 1/5), version 0B



(a) Drill hole size for extensometer head as defined as 300 x 500 mm, but it is noted that drillhole is "according to instrument size. Type of instrument should be known. Therefore, drill hole size can be defined.

(b) The steel protective cap needs to have a thickness of 5 mm at least, better 8 mm.

(c) The protective cap must protrude at least by 100 mm over the borehole collar, and it must be fixed to the shotcrete liner with short rock anchors, which is already in place. All this must be detailed in the drawing.


NOTE
1. All dimensions are in millimeters, and coordinates, chainage and elevation are in meters unless otherwise stated in the drawing.
2. Layout of Underground powerhouse and Transformer cavern is subject to the drawing UT1-C-300-CVL-DG-60001.
3. All monitoring instruments should be installed as early as possible and must a talled before the side drifts in the crown section are opened.
4. Besides deep deformation & convergence measurement, other monitoring items can be carried out as per actual cond nd request of Employer or onsite OE during construction.
5. All cables are protected by PVC/rubber pipes embedded in the shotcrete liner.Attention shall be paid to prevent cables from being damaged during construction.
6. The monitoring station of Underground powerhouse and Transformer cavern is arranged at generator floor at EL.915.70m

(a) Revise: „All monitoring devices, foreseen in the Central Crown Section, must be installed before opening of the Side Drifts".

(b) Replace "other monitoring items" with "additional instruments".

Drawing No.: UT1-C-845-CVL-DG-70002 (sh. 2/5), version 0B

Technical requirements of multi-point extensometer Rev.B

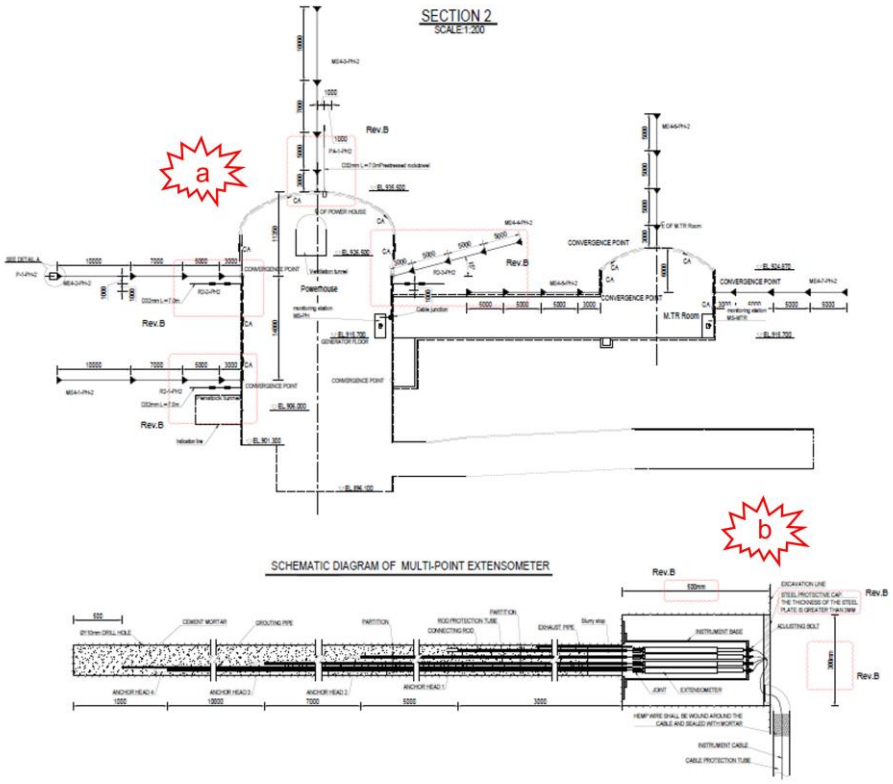
1. When the position of the Multi-point extensometer conflicts with that of the anchor bolt, the position of the multi-point displacement meter can be adjusted within 2m.
2. The hole wall of the multi-point extensometer is smooth,the bending degree of the axis should be less than the radius of the hole,the deviation of the whole hole (compared with the design value)should be less than 1,and the hole mouth should be stable and smooth
3. The hole should be expanded from 50cm deep to 300mm in order to facilitate the installation and protection of the sensor at the end of the multi-point extensometer.
4. After drilling,it should be washed (blown by high pressure wind),checked the unobstructed condition of drilling,and measured the depth,orientation and inclination Angle of drilling.
5. The drilling conditions should be recorded in the process of drilling to understand the geological conditions of surrounding rock and facilitate the accurate positioning of anchor head of multi-point extensometer.
6. The joint between the protective pipe and the joint between the protective pipe and the anchor head must be sealed.Bind the assembled multi-point extensometer,grouting pipe and exhaust pipe segment by segment,and mark each meter of protective tube with colored adhesive tape,and then slowly feed into the hole. The grouting pipe of the vertical hole and the upward hole is at the mouth of the hole, and the exhaust pipe is at the bottom of the hole. The grouting pipe of the horizontal hole is at the lower part of the hole, and the exhaust pipe is at the upper part of the hole.
7. Backfill grouting should ensure full grouting of borehole.w/c-ratio of grout is 0.5:1 or 0.6:1.Grouting can be suspended after the exhaust pipe discharge thick slurry.Grouting can be done again after 15 minutes,and the grouting pipe will be tied to close the grouting after the exhaust pipe has discharged the thick slurry again.
8. To confirm functionality of extensometer, a reading shall be performed directly after grout setting.24 hours after the final grout setting.fix the sensor device,draw out the cable,install the protective cover and hole protection cover,and obtain the initial reading.
9. After installation,spray the instrument number on the Steel cap\ concrete or rock near the measuring point with red paint. Rev.B

(a) Provide/describe the detailed geometry of the expanded section of the borehole for the extensometer head (refer to the revised drawing No.: UT1-C-845-CVL-DG-70002 (sh. 1/5), version 0B).

NO.	NAME	LEGEND	SYMBOL	QUANTITY	UNIT	REMARK
1	Multi-point extensometer		ME4	25	set	Vibrating wire displacement transducer,Range 100mm,Resolution0.025%F.S..Including sensor, connecting rod, rod protection tube, anchor head, partition plate, instrument base and other orifice devices.
2	Hole for Multi-point extensometer			530	m	Borehole diameter Ø110mm, single hole depth 26m or 19m,including backfill grouting.The hole for installing the piezometer at the bottom of the hole is 27m deep.
3	10 cores cable for vibrating wire type		CA	1580	m	10 core, galvanized copper wire.For multi-point extensometer,Anchor dynamometer.
4	Piezometer		P	5	pieces	Vibrating wire instrument,Range 1PMa,Resolution0.025%F.S..
5	4 cores cable for vibrating wire type		CA	3300	m	4 core galvanized copper wire.For piezometer, anchor bar stress meter,Shotcrete pressure cell.
6	Anchor dynamometer(Load cell)		PA	3	set	...nstrument,Range 400kN,Resolution0.03%F.S...3wires.
7	Two-points anchor bar stress meter		R2	9	set	Vibrating wire instrument,Range 400MPa,Resolution0.05%F.S..Each set of instruments includes two sensors.
8	Shotcrete pressure cell		C	12	set	Vibrating wire instrument,Resolution0.04%F.S..Range :radial direction:7MPa;tangent:20MPa.
9	Convergent measuring point				set	...ent measuring points shall be calculated according to the monitoring section.
10	Hub box		B	7	set	...pass to 20 instruments,Protect with a homemade protective box.
11	Cable protection tube			530	m	50mm-100mm diameter,thick and flexible PVC/rubber pipes.

(a) Number of extensometers increased from 22 to 25, but borehole length for extensometers increased from 523 m to 530 m, only. Clarify.
(b) Three load cells for 270 rock bolts, only? Increase to at least 12.
(c) Nine sets of dowel stress meters for more than 1000 rock dowels of the Powerhouse? Use 2 for each wall of the monitoring sections (= (3+2) x 2 x 2). Add for stress meters for the dowels in the roof. Adds up to 24 in total, not 9.

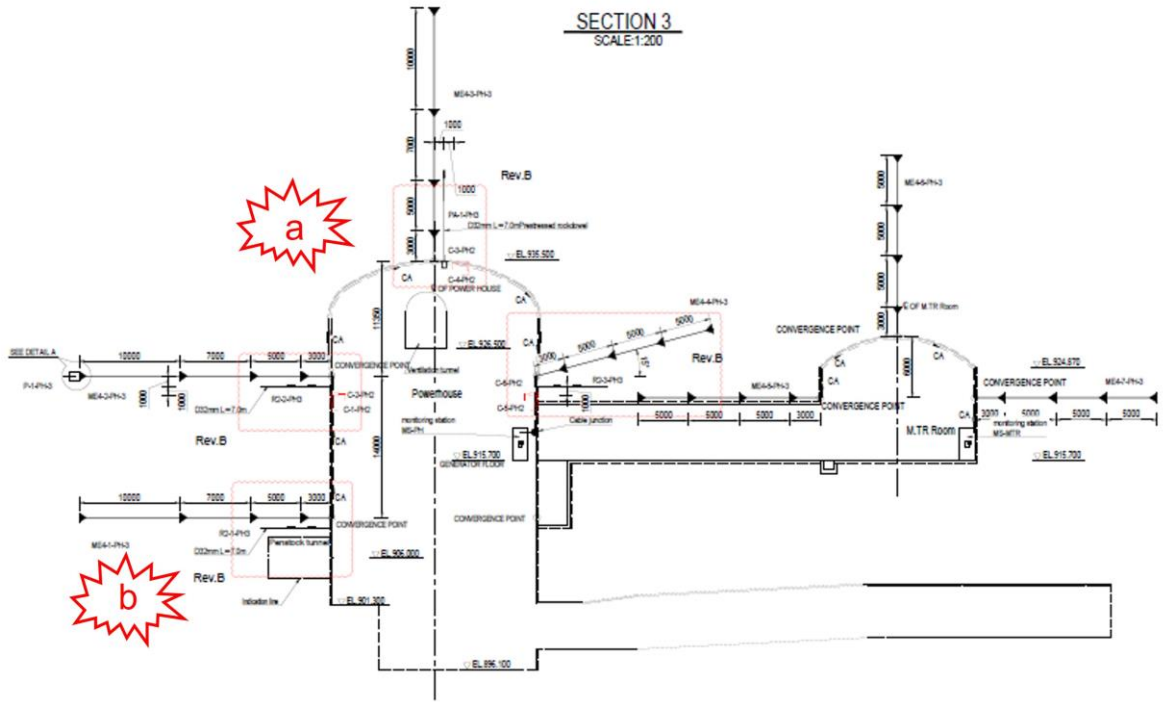
Drawing No.: UT1-C-845-CVL-DG-70002 (sh. 3/5), version 0B



(a) Provide legend of instruments (also in the other drawings that show sections).

(b) Comments on extensometer apply as for drawing No.: UT1-C-845-CVL-DG-70002 (sh. 1/5), version 0B.

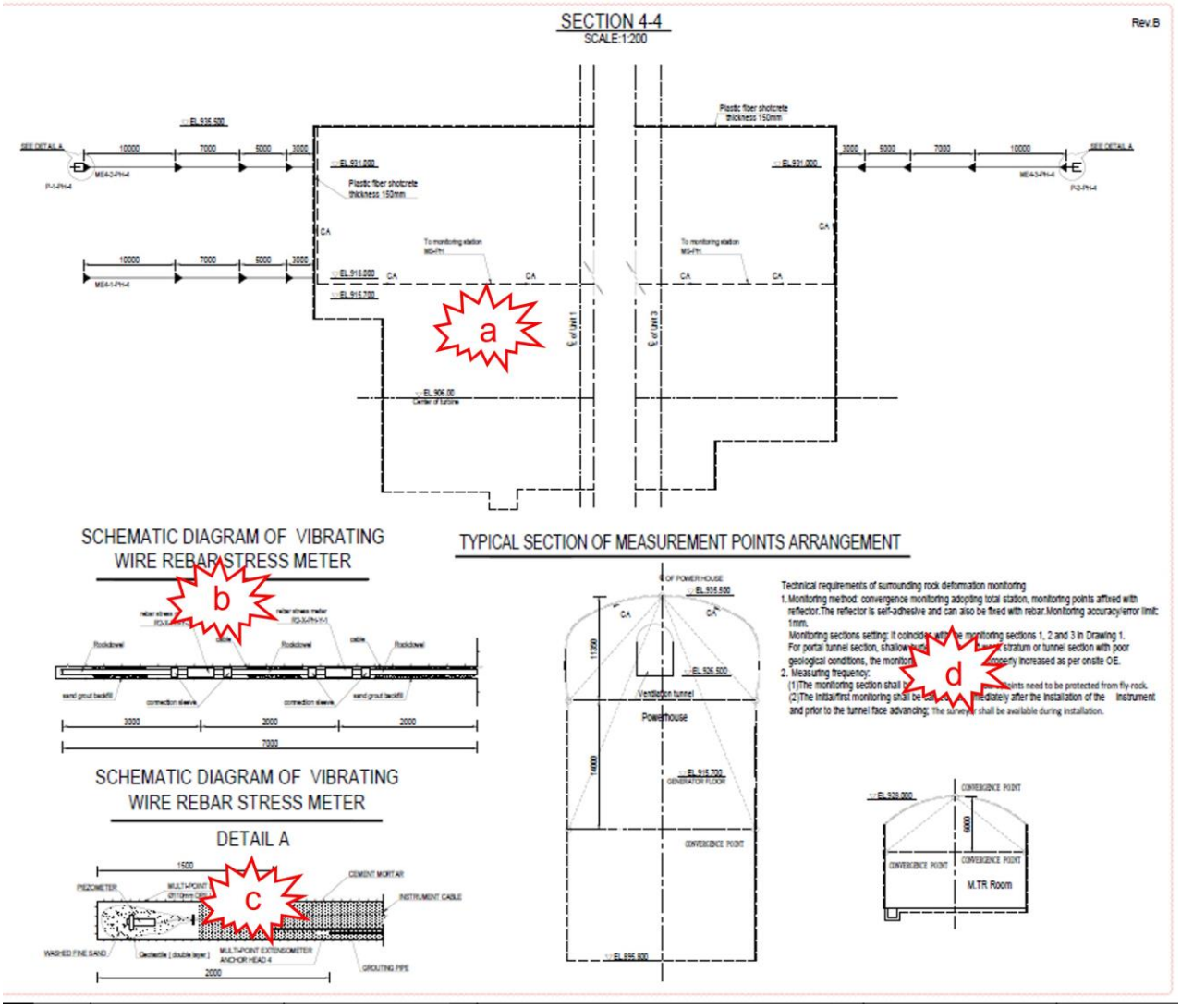
Drawing No.: UT1-C-845-CVL-DG-70002 (sh. 4/5), version 0B



(a) Comments apply as for drawing No.: UT1-C-845-CVL-DG-70002 (sh. 3/5), version 0B, above.

(b) As (a).

Drawing No.: UT1-C-845-CVL-DG-70002 (sh. 5/5), version 0B

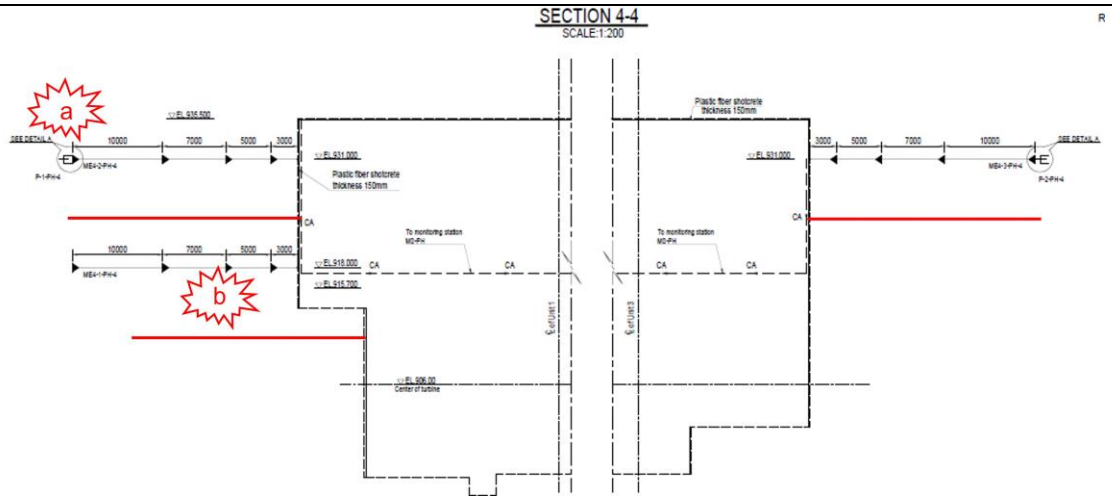

SECTION 4-4
SCALE:1:200
Rev.B
Plastic fiber shotcrete thickness 150mm
a
SCHEMATIC DIAGRAM OF VIBRATING WIRE REBAR STRESS METER
b
TYPICAL SECTION OF MEASUREMENT POINTS ARRANGEMENT
Technical requirements of surrounding rock deformation monitoring
1. Monitoring method: convergence monitoring adopting total station, monitoring points affixed with reflector.The reflector is self-adhesive and can also be fixed with rebar.Monitoring accuracy/error limit: 1mm.
Monitoring sections setting: It coincides with the monitoring sections 1, 2 and 3 in Drawing 1.
For portal tunnel section, shallow buried stratum or tunnel section with poor geological conditions, the monitoring
property increased as per onsite OE.
2. Measuring frequency:
(1)The monitoring section shall be
points need to be protected from fly-rock.
(2)The initial/first monitoring shall be carried out
mediately after the installation of the instrument
and prior to the tunnel face advancing; The surveyor shall be available during installation.
d
Powerhouse
Ventilation tunnel
CONVERGENCE POINT
M.T.R Room
SCHEMATIC DIAGRAM OF VIBRATING WIRE REBAR STRESS METER
DETAIL A
c
PIEZOMETER
CEMENT MORTAR
INSTRUMENT CABLE
WASHED FINE SAND
GROUTING PIPE

(a) Adjust the monitoring system as sketched further below.

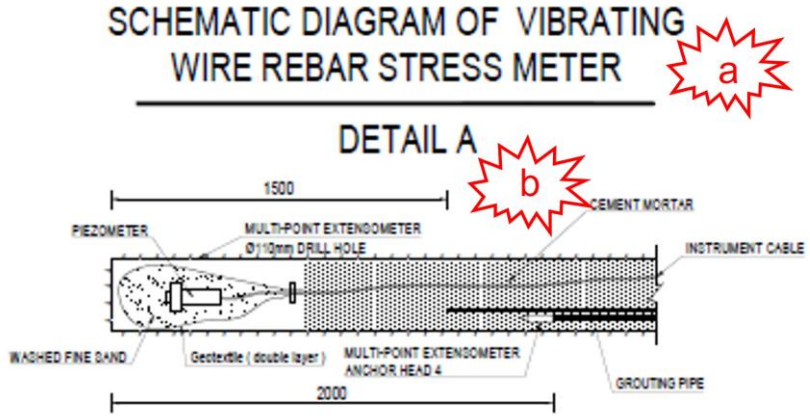
(b) These instruments need also be installed on 5 m long dowels with one sensor, only. Provide respective sketch.

(c) Piezometers need to be installed in separately drilled holes, not in extensometer holes. Generally, such holes are percussion drilled and 10 m to 15 m long. Locations are selected at the site. Five pieces as listed in drawing No. UT1-C-845-CVL-DG-70002 (sh. 2/5), version 0B, are sufficient.

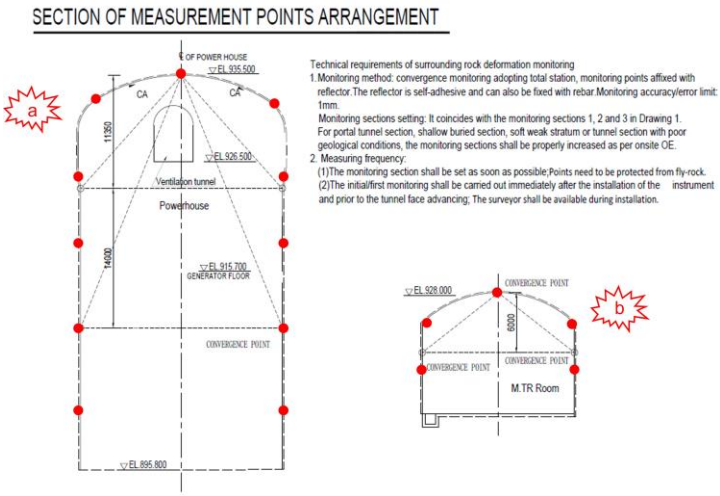
(d) See details referring to convergence measurements below. Adjust the notes to the Powerhouse and Transformer Hall. Currently it refers to a tunnel. Add a note that additional targets may be required and installed, elsewhere, if necessary. Revise.



(a) Piezometers shall not be installed in extensometer boreholes. Revise.
(b) Rearrange location of extensometers as suggested (red lines).

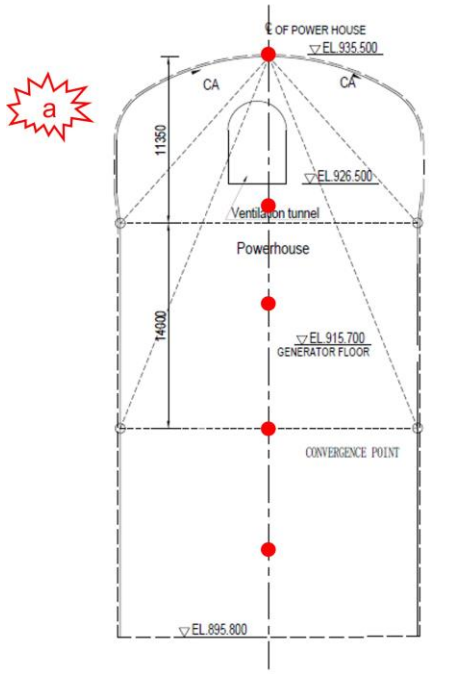


(a) „Details of Piezometer Installation“ and not Vibrating Wire Stress Meter”. Revise
(b) Revise drawing for a piezometer – not installed in an extensometer borehole.


SECTION OF MEASUREMENT POINTS ARRANGEMENT
a
OF POWER HOUSE
EL 935.500
CA
CA
11350
EL 926.500
Ventilation tunnel
Powerhouse
14000
EL 915.700
GENERATOR FLOOR
CONVERGENCE POINT
EL 895.800
Technical requirements of surrounding rock deformation monitoring
1.Monitoring method: convergence monitoring adopting total station, monitoring points affixed with reflector.The reflector is self-adhesive and can also be fixed with rebar.Monitoring accuracy/error limit: 1mm.
Monitoring sections setting: It coincides with the monitoring sections 1, 2 and 3 in Drawing 1. For portal tunnel section, shallow buried section, soft weak stratum or tunnel section with poor geological conditions, the monitoring sections shall be properly increased as per onsite OE.
2. Measuring frequency:
(1)The monitoring section shall be set as soon as possible;Points need to be protected from fly-rock.
(2)The initial/first monitoring shall be carried out immediately after the installation of the instrument and prior to the tunnel face advancing; The surveyor shall be available during installation.
EL 928.000
CONVERGENCE POINT
b
6000
CONVERGENCE POINT
CONVERGENCE POINT
M.TR Room

(a) Produce typical drawing for optical targets for convergence measurements. Here at the monitoring cross sections in the Powerhouse and in the Transformer Hall. Delete the dotted lines. Adjust, if necessary, targets to the location of extensometers.
(b) As (a).

SECTION OF MEASUREMENT POINTS



(a) Produce typical drawing for optical targets for convergence measurements for the end walls. Delete the dotted lines. Adjust, if necessary, targets to the location of extensometers.

Count all optical targets and include in list of drawing No. UT1-C-845-CVL-DG-70002 (sh. 2/5), version 0B.

DISCLAIMER

Any approval will not release the Contractor from any of his obligations under the Contract.

Dr. U. Glawe